ENHANCING THE EFFICIENCY PROCESS FOR SEPARATION OF DRY SHELL AND PALM KERNEL

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ABSTRACT

Palm kernel is one of the products from palm oil mills. In kernel recovery plant, the separation of kernel and shell from cracked mixture is carried out using a combination of dry and wet separation. The objective of this study were to enhance the efficiency process for separation of dry shell an palm kernel as well as to maximizing the recovery of dry kernel and shell based on the installation of four stage winnowing column. This user friendly and compact separation device uses forced draught principle instead of the usual induced draught. The air flow velocity in each separating column can be adjust via the blower (damper) located at the ground or an elevated level. The effect of velocity and fan air speed in activity of separation must take in consideration. The parameter that has been monitored during the trials was dirt & shell content in production kernel, kernel losses and effect of velocity on efficiency of separation. The system was also equipped with a unit of a small vibro clay bath to minimize the kernel losses by recovering the very fine kernel pieces generated from the screw press. The system was capable separate drier kernel shell. The total kernel loss from dry and wet separation also could be minimized. This four stage winnowing system also reduces the waste effluent from the mill promoting more environmental friendly technology for the oil palm industry.

MENINGKATKAN KECEKAPAN PROSES UNTUK PENGASINGAN SHELL KERING DAN ISIRONG SAWIT

ABSTRAK

Kernel sawit adalah salah satu produk yang dihasilkan dari kilang sawit. Dalam sistem kernel, pemisahan kernel dan shell dari campuran yang telah retak dijalankan menggunakan gabungan pemisahan kering dan basah. Objektif kajian ini adalah untuk meningkatkan kecekapan proses untuk pemisahan shell kering sawit dan memaksimumkan pemulihan kernel kering dan shell berdasarkan 4 stage winnowing column. Penggunan peranti pemisahan mesra alam dan padat ini, menggunakan draf prinsip. Halaju aliran udara dalam setiap kolum memisahkan boleh menyesuaikan diri melalui blower (peredam) yang terletak di tanah atau tahap yang tinggi. Kesan halaju dan kelajuan kipas udara dalam aktiviti pemisahan perlu mengambil dalam pertimbangan. Parameter yang telah dipantau semasa ujian adalah kotoran & shell kandungan dalam kernel pengeluaran, isirong dan kesan halajup ada kecekapan pemisahan. Sistem ini juga dilengkapi dengan satu unit mandi tanah liat kecil Vibro untuk meminimumkan kerugian kernel dengan memulihkan kepingan kernel yang sangat halus yang dihasilkan daripada penekan skru. Sistem itu mampu kering berasingan kernel shell. Kerugian kernel jumlah dari pemisahan kering dan basah juga boleh dikurangkan. Inijelasnya peringkat empat system juga mengurangkan sisa efluen dari kilang menggalakkan lebih teknologi mesra alam untuk industry minyak sawit.

TABLE OF CONTENTS

LIST OF TABLES

PAGE

LIST OF FIGURES

PAGE

LIST OF SYMBOLS

%	Percent
g	Gramme
kg/h	kilogramme per hour
°C	Degree celcius
SG	specific gravity
kW	*kilowatt*

LIST OF ABBREVIATIONS

FFB	Fresh fruit bunch
Wt	Weight
CPO	Crude palm oil
POME	Palm Oil Mill Effluent
EFB	Empty fruit bunch
pH	Potential hydrogen
RPM	Rotation per minutes

CHAPTER 1

INTRODUCTION

1.1 Introduction

Malaysian palm oil industry has developed tremendously and continues to be one of the major contributors for the socio-economic development of the country. Being amongst the world's largest palm oil producers, the industry continues to grow to meet the high global demands for oils and fats. In 2008, Malaysia processed 88.53 million tonnes of fresh fruit bunch (FFB) and produced 17.73 million tonnes of crude palm oil. Besides that, the industry also produced 4.58 and 2.13 million tonnes of palm kernel and palm kernel oil respectively**.** (Wikipedia)

Palm kernel which constitutes about 5-7% in fresh fruit bunch (FFB), is a secondary product from palm oil mills. It is obtained from palm fruitlet after the removal of mesocarpfibre and shell. The production of palm kernel starts with the cracking of palm nuts using palm nut cracker followed by with the separation of shell

and kernel in the cracked mixture using a combination of dry and wet separation. In a typical kernel recpvery plant, two units of winnowing columns operated based on the dry separation principle. They were used to remove the low tension dust particles, broken kernel and other particles of the cracked mixture. The heavier mixture of shell and kernel is then subjected to wet separation using either clay bath or hydrocyclone. Basically, the separation ratio (weight basis) of dry to wet separation 20:80 based on the total cracked mixture fed into the kernel recovery plant. (Rohaya et al 2004)

The commercial dry separation systems uses either forced or induced draught. The wet separation process of cracked mixture is based on the difference between the specific gravity of shell and kernel. The wet technique either through hydrocyclone or claybath is considered less environmentally friendly as it requires a large volume of water and clay which contribute towards a high production volume of waste effluent. Through this conventional process, kernel is produced and collected in a wet condition and requires drying operation prior to stage.

In order to enhance the recovery of dry shell and kernel in palm oil mills. We need to developed an improved dry separation system via a four stage winnowing column (MPOB, et al 2004).

1.2 Problem Statement

The knowledge and capability to understand the principle of velocity and draught forced is become important role in order to separate the kernel and shell. A suction fan will provide the air velocity required to lift the fibers and transport it to the fiber cyclone. Since the conventional system lack in efficiency of product, therefore new technique is required to improve the conventional method.

Based on the commercial performance evaluation of the system in certain palm oil mills show that, the amount of cracked mixture for wet separation is about 60-80 percent. This shows that the system is ineffective based on separation technique. More likely, it will generates less dry shells for fuels and for making activated carbon. This will make the operational cost is highly. On the operational cost, the system is capable of minimizing the clay and water consumption by the conventional system to a minimum. Also, palm oil mill wastewater treatment systems are one of the major sources of greenhouse gases in Malaysia due to their biogas emission (36 % CH_4 with a flow rate of 5.4 l/min.m2) from open digester tanks and/or anaerobic ponds (Yacob *et al.,* 2005)**.** Therefore, palm oil mills in Malaysia face the challenge of balancing environmental protection, their economic viability, and sustainable development after the Department of Environment enforced the regulation for the discharge of effluent from the crude palm oil (CPO) industry, under the Environmental Quality order and regulations, 1997. Thus, there is an urgent need to find an efficient and practical approach to preserve the environment while maintaining the sustainability of the economy.

1.3 Objectives

The purpose of the research is

- To maximizing the recovery of dry kernel and shell via a four-winnowing column.
- To study the effect of velocity and fan air speed damper in activity of separation.
- To compare the conventional separation method with new separation technique.

1.4 Scope of the research work

To achieve the objective, scopes have been identified in this research. The scopes of this research are listed as below:-

- Identification of problem in separation of palm kernel and dry shell
- Identification of the right equipment for separation process
- Study the winnowing column in order to enhance the separation
- Consider the air velocity, fan speed on 4 winnowing column.

  The range for air speed is between 2500 to 2950 rpm.

1.5 Rationale and significance of study

i. The best velocity is required to get minimum kernel losses and increase the efficiency of the method.

ii. Accurate design of separation unit for recovery plant can help minimize the operating cost, low maintenance cost, and reduction in kernel losses.

iii. The range of kernel losses with the month is between 0.9-2.1 percent.

iv. The accurate design of separation process can boost the production of oil, hence eventually can help reducing the effect to the environment.

At the same time, the separation process can improved the kernel quality of the palm shell in which is can reduced the dirt content in kernel.

CHAPTER 2

LITERATURE REVIEW

2.1 The Palm Oil

The oil palm, was first introduced into Malaysia in 1870, through the Botanic Gardens in Singapore. The oil palm industry was introduced to Malaysia in 1917 . The real impetus for the large scale plating of oil palm came about with the government's policy on crop diversification in 1960. As a result of the diversification and modernization strategy implemented through the various agencies, the composition of crops has undergone a shift from rubber to oil palm. By 1970, the hectare under oil palm increase to over a quarter million hectares reaching the 1 million mark ten years later in 1980. By early 1990's the area under oil palm in Malaysia exceeded 2 million hectares an expected to reach 3 million hectares by the end of this century. The growth of oil palm areas is shown in Table 1. (Elaeisgineensis Jacquin, 1990)

The increase in hectare led to a corresponding increase number of oil palm mills and production of crude palm oil. The palm oil industry is primarily export-oriented. Currently, there are 326 oil palm mills in Malaysia with a total production more than 8.32 million tonnes per years (Aon, 2000). In 1974 oil palm industry enter a new phase on its development with the establishment of the first palm oil refineries. Currently, there are 45 palm oil refineries in Malaysia with a total capacity of 12.73 million tonnes crude palm oil per years. Further downstream of the oil palm industry took place in 1982 when the first oleochemical plant was set up in this country and currently there are 13 oleochemical plants ae in operation. Malaysia ranked as the world's largest producer and exporter of palm oil. (Yusof and Ariffin, 1996).

There is no denying that the industry has an impact on the environment. The oil palm industry as a whole generates a number of by-products and residues. It could be expected to occur both upstream in relation to the cultivation of the crops ad also in the downstream processing activities.

The main residues from the milling of the fruit bunches are the mesocarpfibre, shell, palm kernel cake, boiler ash, empty fruit bunches, palm oil mill effluent (POME) and bunch ash. These by products are obtained at different stages of the milling process. The mesocarp fiber and shell are but as fuel in the boiler to produce steam and electricity for various mill processes.(MPOB, 2004)

Table 2.1: Area of oil palm plantation in Malaysia

Year	Hectares	% Change
1871-1910s	<350	-
1920	400	-
1930	20600	-
1940	31400	-
1950	38800	-
1960	54638	0.0
1970	261199	169.4
1980	1023000	59.4
1990	2029464	36.9
1995	2540087	25.2
1996	2692286	6.0
1997	2819316	4.7
1998	30778116	9.2

Source: Statistics of Commodities, Ministry of Primary Industries

Based to the mature hectares in 1997 at 2,455 million hectares and in year 2000 at 2,813 million hectares, the amount of dry matter based on the fresh weight obtained(Chan et all 1981) for EFB. Fiber, shell and POME are shown in Table 2.

Table 2.2: The amount of by-product from palm oil mills

Year	Location	By- products in million t/year			
		EFB	Fibre	Shell	POME
1997	Penisular	7.823	4.797	1.947	23.806
	Sabah and Sarawak	3.028	1.856	0.754	9.213
		10.851	6.653	2.701	33.019
2000	Penisular	8.288	5.081	2.062	25.219
	Sabah & Sarawak	4.146	2.542	1.032	12.616
		12.434	7.623	3.094	37.835

Source: Chan, 2000

The palm oil mill generally has excess fiber and shell which are not used and to be dispose of separately otherwise contribute to environmental pollution.

2.2 Palm Kernel Shell

Palm kernel shell that we are referring is palm kernel from oil palm fruit. As showed in the image, every oil palm fruit is consists of oil palm nut, and mesocarp (the meat). In palm oil industry, the crash shell without nut is referring to palm kernel shell.

At crude palm oil process, after the Cyclone Separation process, mesocarpfibre and oil palm nut will be separated. The oil palm nut will go through nut drying process and then later for nut cracking. Kernel will be separated for kernel oil process and the nut shell will become the palm kernel shell. Palm kernel shell will be pile up and store at open space.

Palm kernel shell can be considered as pellet form because of it nature form, due to its high grade solid, low ash and low sulphur content, palm kernel shell has been used as a burner for power plant. One of the most favorable used of palm kernel shell is to process become charcoal.

Furthermore, the burned palm kernel shell charcoal has other economy value too. Palm kernel shell charcoal has also been used as activated carbon for water purification, promote organic farming, and also an active agent for soil improvement. Apart, we also read some articles that researcher already study to include palm kernel

shell as a coarse aggregate in road binder courses with emphasis on strength of the asphalt concrete.

In short, researchers have put in afford to develop application for palm kernel shell, and we believe palm kernel shell be much more valuable from biomass aspect (HCT Company, 2009)

2.3 Application of Palm Kernel Shell

Palm kernel shell has become one of the valuable commodities in palm oil industry, many usages or application has been developed. Due to high calorific value of palm kernel shell, this commodity has been one of the key biomass material in order to replace fossil fuel for steam power plant, however due to more and more study conducted, it value has been elevated. Carbonize Palm Kernel Shell can be used as charcoal which can be pressed into bio-fuel briquette, these form of charcoal could be directly sell to consumer such for BBQ or family use. We also seeing part of the carbonize Palm Kernel Shell also being processed into activated carbon which use in liquid and gaseous phase filtration or adsorption. More advance study has carried out at university, the research reveal the advantage on palm kernel shell as partial replacement for coarse aggregate in asphalt concrete.

2.3.1 Charcoal

Charcoal is a very useful item but many people usually take it for granted. They know that it is used in barbecue cooking and other broiled food, but more often they do not realize that it has countless other uses, especially in industry. All species of wood can provide charcoal that suitable for general use such as fuel for homes and industry (Anon, 1957). Charcoal is also an important commodity for the reduction of steel, production of carbide and activated carbon in Malaysia.

2.4 Chemical Composition for Palm Kernel Shell

Palm kernel shell can be considered as pellet form because of it nature form, due to its high grade solid, high calorific value, low ash and low sulfur content. From biomass aspect, the calorific value 20100kJ/kg and solid form has become one of the most favorable biomass media. It always mixes with EFB fiber n certain ratio to burn in the biomass boiler. (MPOB,2004)

Table 2.3: Property and value of palm kernel shell

Property	Value
Moisture %	13
Caloric	20100kJ/kg
Sulphur	0.09
Ash %	3

2.5 Depreciating or nut/fiber separation

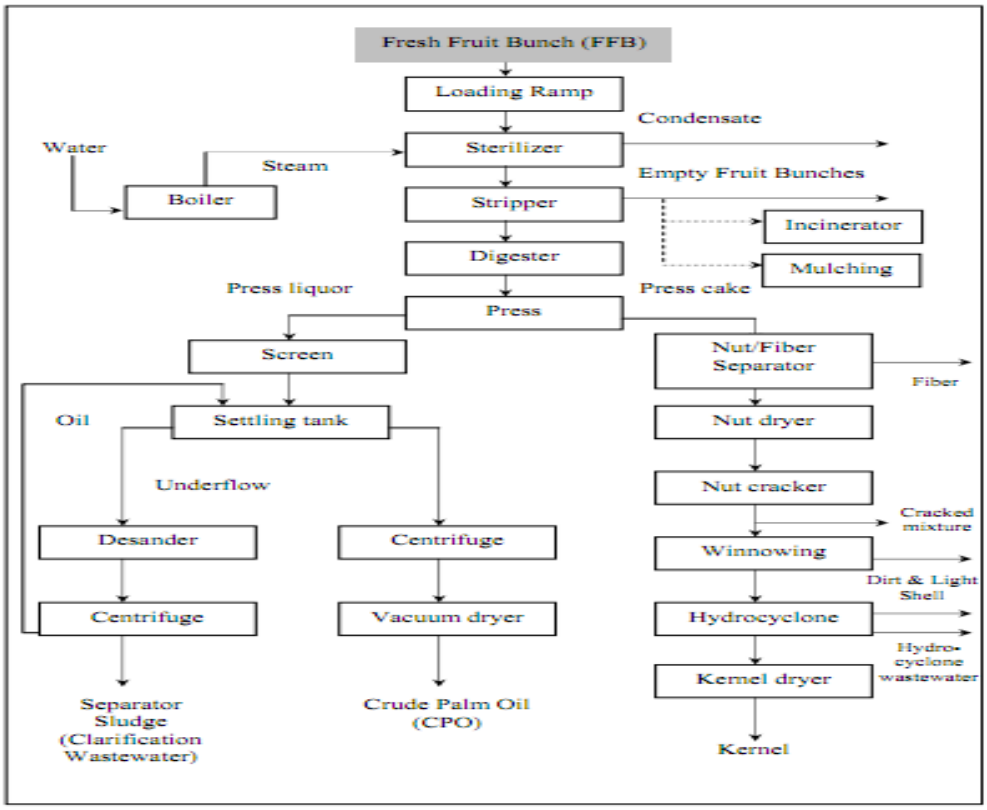

Figure 2.1: Process for separating kernels and shells

The matte or press cake discharged from the screw press consists mainly of moist oily fibres and nuts and fibre mixture is conveyed to the depricarper. The covenyer normally used is fitted with paddles and these paddles help to break-up the press cake as it is transported to the deprecarper. (This conveyor is often referred to as the cake breaker conveyor). The depericaper consists basically of a vertical duct connected at its top to a powerful suction fan and the discharge from this fan is led to a cyclone. The bottom of the duct discharges into a rotating drum. The broken-up press cake is fed into the duct near to its top and the fibres being lighter than the nuts are carried up-wards by the air current and discharged at the lower outlet of the cyclone. These fibers are used as biler fuel. The nuts being heavier than the fibres

drop down the duct into the rotating drum where any remaining fibres are removed from the nuts (MPOB et al 2004)

2.6 Nuts drying and cracking

The nuts from the depericarper are conveyed to nut drying silo where they are held for 16 to 24 hours depending on whether any heat is applied to the silo. In some mills hot air is blown into the mass of nuts being dried and them the smaller retention time is sufficient to “dry” the nuts. The main aim of drying of conditioning of the nuts is to shrink the kernel away from the shell thus assisting the breaking of the shell with the minimal damage to the kernel.

After drying the nuts are cracked by centrifugal force. In this type of nut cracker the nuts are forced into a high speed rotor which throws the nuts against surrounding cracking ring. The material leaving the cracker i.e kernels, pieces of shell and free uncracked nuts, is referred to as ‘cracked misxture’.(Rohaya et al 2004)

2.7 Separation of kernels and shell

Hydrocyclone are mainly used for separating the cracked mixture and basically a hydrocyclone separator consists of two tanks, each with suitable pumps, and two cyclones. Due to the difference in specific gravity between kernels and shell